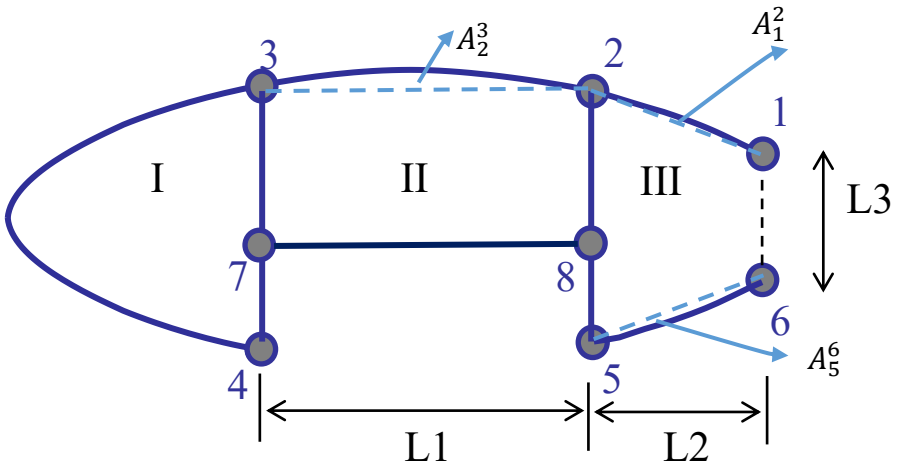
Aeronautical Structures (MECA0028-1)

June 2026

Question n° 1



The wing depicted here above has the idealized cross-section properties reported in the five Tables here below. The cell number III is not closed (there is no wall between booms 1 and 6). The **booms distribution is not symmetrical.** The "arc" table refers to the are between the dashed line and the arc, while the "cell" table to the whole cell area (including the arc areas).

Wall	Length (mm)	Thickness (mm)	Shear modulus (GPa)
12, 56	618	1.	22
23	920	1.	22
34(	1220	1.	22
37	250	1.	22
74	115	1.	22
28	250	1.	22
85	115	1.	22
78	914	1.	22

Boom	Section (mm^2)
1-6	1 000
7-8	1 500

Arc	Area (mm^2)
A_1^2	7 975
A_5^6	7 975
A_2^3	19 500

Cell	Area (mm^2)
I	134 000
II	248 000
III	202 000

Distance	Length (mm)
L1	914
L2	610
L3	245

We consider the following assumptions

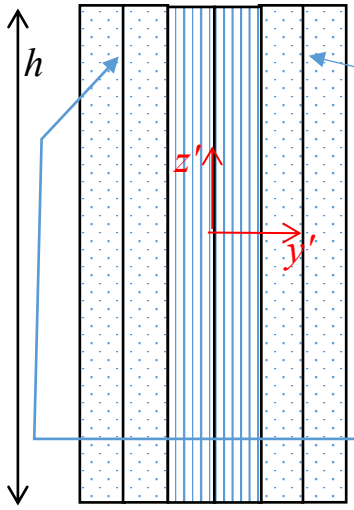
- The booms carry the direct stress (due to bending) only;
- The skin panels sustain the shear stress only;
- The taper effect can be neglected;
- Twist and shear centres are assumed to coincide.

You are requested to compute

A) The bending inertia centre of the wing section.
B) The location of the shear centre of the wing section.
C) The twist rate for a load T_y= 3kN, T_z = 8kN passing through this shear centre.

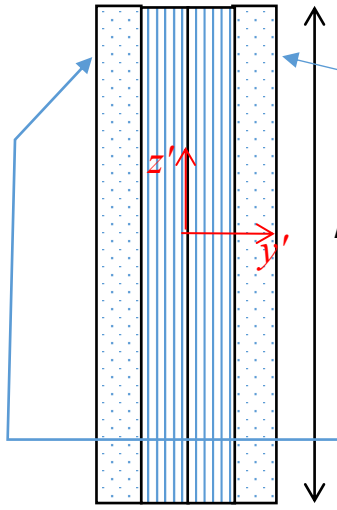
Question n° 2

Boom 1, 2, 8

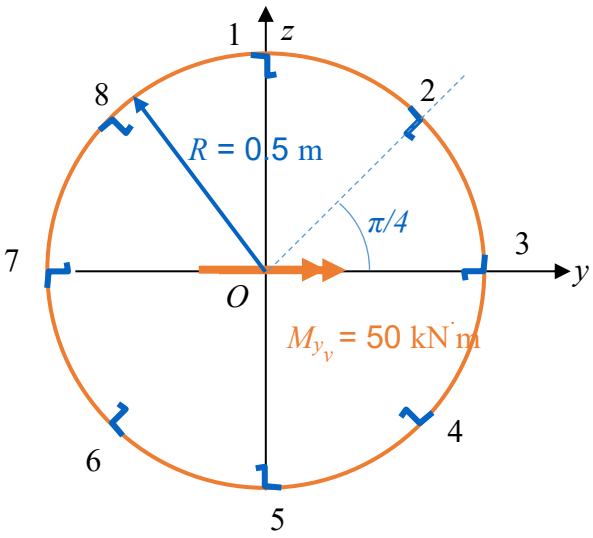


Ply number	Orientation
1	0°
2	0°
3	90°
4	90°
5	0°
6	0°

Boom 3-7



Ply number	Orientation
1	0°
2	90°
3	90°
4	0°



Material properties	Values
Matrix Young's modulus E_m	3 GPa
Matrix Poisson coefficient υ_m	0.3
Fibre Young's modulus E_f	250 GPa
Fibre Poisson coefficient υ_f	0.2
Fibre volume fraction v_f	**60 %**

Geometrical properties	Values
Ply thickness t	0.2 mm
Web height h	30 mm

The stringers of a fuselage are made of a composite laminate as illustrated in the Figures here above. Each ply is made of a unidirectional composite (continuous isotropic fibres embedded in an isotropic matrix), with a fibre volume fraction v_f. Each ply has a uniform thickness t and an orientation (the orientation of the carbon fibres) related to the x-axis. Material and geometrical properties are reported in the Tables here above.

Using the thin wall assumption, and considering that the cross-section has already been idealized, you are requested to evaluate

1) The homogenised Young's modulus of the plies along the x-direction ($E_x^{0°}$, $E_x^{90°}$)
2) The location (C_y, C_z) of the inertia centre C governing the bending behaviour of the fuselage cross-section
3) The maximum stress in the different plies of each stringer for M_y=50 kN m.